IMAGE PROCESSOR

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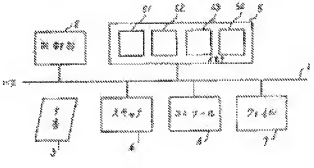
Abstract of **JP 9120430 (A)**

PROBLEM TO BE SOLVED: To speedily correct the tilt of an image by extracting the contour of the image and also the tilt of a rectilinear part such as a horizontal rule, etc., and correcting the tilt of the rectilinear part into a horizontal or vertical state. SOLUTION: The software of a control part 2 extracts the contour of an image stored in a memory 51 and stores it in a memory 52. Then the coordinates of four corners are calculated based on the contour data stored in the memory 52 and stored in a memory 53. The contour data stored in the memory 52 undergo the tilt correction processing and the corrected contour data are stored in a memory 54. An area-filled image is generated from the corrected contour data, and an image undergone its tilt correction is obtained in the memory 51. Then an address contained in a file 7 storing the corrected image is decided by the interaction carried out with a user using a console 6 and stored in the file 7. Thus the contour of an image is extracted and the tilt of a rectilinear part such as a horizontal rule, etc., is extracted. Then the tilt of the rectilinear part is corrected into a horizontal or vertical state.



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NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]An image processing device comprising:
An input means which inputs digital image information.
A memory which stores the above-mentioned digital image information.
A means by which it has a control section which processes digital image information in this memory, and this control section extracts contour data of the above-mentioned digital image information, A means to compute characteristic quantity by calculating this contour data, a means to project this characteristic quantity in two or more directions, to integrate with it, and to acquire an integral value, a means to extract a direction in which this integral value takes an extremum.

[Claim 2]An image processing device comprising:
An input means which digital-image-information-izes a document and inputs it.
A memory which stores the above-mentioned digital image information.
A means by which it has a control section which processes digital image information in this memory, and this control section extracts contour data of alphabetic data in the above-mentioned digital image information, A means to compute characteristic quantity by calculating this contour data, a means to project this characteristic quantity in two or more directions, to integrate with it, and to acquire an integral value, a means to extract a direction in which this integral value takes an extremum.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to an image processing device, especially relates to the suitable image processing device for normalization of inclination of a document image.
[0002]
[Description of the Prior Art]In conventional document image processing, especially binary document image processing, after performing photoelectric conversion and digitization for a

picture and changing an inputted image into a digital image, usually it processes. Under the present circumstances, the device for the photoelectric conversion and digitization to be used is called a scanner. In the case of the human power of a picture, the relative inclination by the document and a scanner is not avoided, but inclination of the picture produced as a result has an adverse effect on document image processing, for example, extraction of the character string in a document. Even if it can make relative inclination by the document and a scanner very small, when the case where a document is drawn up with a typewriter, and a document are copied, the character string in a document may lean from the first to the paper.

[0003]Conventional technology is integrated with a document image to two or more directions, in order to cope with such a problem, A direction which serves as a peak is searched for, and the way the direction rotates a document image only the edge of space and the angle to make is known, for example, the integral value is reported by the Institute of Electronics and Communication Engineers national conference lecture collected papers No. 1769th "character logging method on the list which has a black background" in the Showa 59 fiscal year. However, this method had the problem that a throughput became huge, in order to calculate about the gray level of all the pixels.

[0004]

[Problem(s) to be Solved by the Invention]The purpose of this invention is to provide the document image processing device which can amend inclination of a picture at high speed.

[0005]

[Means for Solving the Problem]In order to attain this purpose, this invention extracts inclination of a straight-lines portion, such as a ruled line, from an outline extracted from a picture by performing outline extraction, and amends inclination of a picture at high speed by amending inclination so that inclination of this straight-line portion may become level (or vertical).

[0006]The principle is shown in drawing 1. A picture acquired by drawing 1's (A's)'s performing an example of a document image, and (B) performing outline extraction from (A) and (C) show a picture which extracted only an outer contour in (B). The outline 21 of (B) is obtained corresponding to the ruled line 11 of (A). 21 of (C) shows the same outline. An outline is distinguishable as an inner contour, if it is expressed as a coordinate sequence when seeing and going around a black material on the left, it goes around an it top counterclockwise in that case and it will go around to an outer contour and a clockwise rotation.

[0007]A contour coordinate series is set to ((Xj, Yj), j= 0, 1 and 2, L-1) (L is the length of sequence of points). It can ask for four corners of the outline 21 like drawing 1 (D) by searching for a point of giving the maximum and the minimum of quantity (Xj-Yj) of two pieces, and (Xj+Yj) at this time. However, (D) has expanded and shown the outline 21.

[0008]Only a long and slender outline can be extracted by asking for four corners of an outline about all the outlines, and finding a distance in the meantime. When it turns out that only a ruled line (it is level) and a character part exist on a document, the above-mentioned long and slender outline is a ruled line, and can ask also for the horizon and an angle to make using coordinates of outline 4 corner. What is necessary is just to rotate the whole document image using this angle, so that a ruled line may become level. Although a ruled line is one intelligible example, as theoretically shown in drawing 1 (c), each outline of each character has also turned to a direction with specific ** and its neighborhood in many cases.

[0009]Although rotation may carry out straight-line rotation of the original image, after transforming about a contour coordinate series, it may be returned to a picture. When long and slender patterns other than a ruled line exist on a document, the linearity of sequence of points

which connect between outline 4 corners is authorized, and only a ruled line can be extracted. What is necessary is to extract only the horizon and a perpendicular line (almost level or vertically near line) in quest of a slope of a line similarly, and just to amend inclination of a picture at high speed by amending inclination using the either, when **** and a perpendicular line also exist as a straight line on a document.

[0010]In a mode of this invention, feature quantity is calculated from an outline extracted from a picture, It integrates with this characteristic quantity in the various directions, and a direction that that integral value serves as a peak is searched for, and that direction amends inclination of a picture at high speed, when only edge of space and an angle to make amend inclination.

[0011]As an example of feature quantity to an outline extracted from a picture, a rectangle circumscribed to an outline (outer contour) can be made, and the length of a neighborhood of the length or width can be taken. This method can be used in order to ask for inclination of a character string, when a ruled line does not exist. As other examples, arbitrary values of a function calculated a rectangular area and based on these values can be considered.

[0012]The principle is shown in drawing 2 and drawing 3. A picture acquired by drawing 2's (A's)'s performing an example of a document image, and (B) performing outline extraction from (A) and (C) show a picture which extracted only an outer contour in (B). A bounding rectangle as shown in (D) is made from an outer contour of (C). Coordinates of a bounding rectangle are (PXj, PYj), (QXj, QYj), and (RXj, RYj) (SXj, SYj) about this, although it asks easily from the maximum of contour point sequence coordinates, and the minimum,

It carries out. Here, P, Q, R, and S express the upper left of the bounding rectangle j, the lower left, the lower right, and the upper right, respectively. Namely, (QXj, QYj) (RXj, RYj),

A picture of the lower side of ********** and the bounding rectangle j is expressed. At this time, the following quantity V (alpha) is calculated to a certain angle alpha. First, arrangement H (k) which stores a histogram, k= 0, 1 (N-1),

It clears zero times. It is the length of length when N document image is made into MxN. Next, H(Kj) <-H(Kj)+|QXj-RXj|, however Kj=G [QYj-QXj-tan (alpha)] are calculated by a loop about j. A sign "<-" as used in the above means substitution, and G[x] shows a function which changes the real number x into an integer.

[0013]As shown in drawing 3, Kj is a Y coordinate of a point which crosses the left side 32 of a picture, when a straight line of the angle alpha is drawn from the point Qj of a lower left corner of the bounding rectangle j of 31. Therefore, the histogram H (Kj) is equivalent to only the angle alpha leaning a picture and integrating with the length of the lower side of the bounding rectangle j. This is called side length marginal distribution of the direction of angle alpha. An end of a loop about j will calculate V(alpha) = sigma|H (k)-H(k-1) |. V (alpha) is the quantity showing sharpness of side length marginal distribution of the direction of angle alpha. A direction with which the lower side of a bounding rectangle laps best can be found by changing the angle alpha by 0.1-degree unit from -2 degrees to +2 degrees, and asking for an angle used as the maximum of V (alpha). Generally as for a line of a character, the lower sides can consider mostly printing or an angle which is located in a line on the line with this same since it is written to be inclination of a character string together.

[0014]A case where the length of a rectangular base is used as a feature value using drawing 7 is explained still more nearly plainly. Drawing 7 (a) is a figure when it asks for the histogram H (K) at the angle alpha equal to an angle of inclination. A circumscribed rectangle of a character is shown by sequence of a rectangular head. As shown in the figure, when it integrates with the length of a rectangular base in the direction equal to an angle of inclination, a histogram has a

big value in a position corresponding to each character row. Supposing a rectangle which shows an outline of a character is completely regular, a point of a lower left corner of each rectangle will be located in a line with straight line shape, and a histogram has a peak only in a corresponding position at the figure so that it may be shown. Therefore, since V (alpha) to this is the value which integrated with difference of a value of the next doors of H (K), a big value will be taken. Actually, although a character pattern differs in shape or a size, respectively, a tendency which a histogram shows does not change even in such a case.

[0015]On the other hand, when the direction alpha with which it integrates differs from an angle of inclination like drawing 7 (b), a sharp peak has distribution in the surroundings of a position corresponding to each character row, without appearing. Therefore, V (alpha) to this is small much compared with drawing 7 (a). Thus, by calculating V (alpha), inclination of a picture can be known about two or more directions using V (alpha) becoming the maximum at the time of alpha near the degree of angle of inclination. Although the length of a neighborhood of a rectangle circumscribed to a character was made into characteristic quantity in this example, it is clear that effect same also as characteristic quantity is acquired in a rectangular area.

[0016]

[Example]Hereafter, the example of this invention is described in detail using a drawing.

[0017]Drawing 4 is a block diagram showing the composition of the device which adopted the word-processing method by one example of this invention. Each part of a device is connected to the bus 1, and the whole operation is controlled by the control section 2. Photoelectric conversion and digitization of the information (document image) on the document 3 are done with the scanner 4, it serves as a digital image, and is stored in the memory 51 via the bus 1. The memory 51 makes a part of memory 5 with 52, 53, and 54 which are mentioned later. Instead of obtaining the digital image 51 from the scanner 4, you may also read from digital image filing devices, such as an optical disc. Although binarization shall be carried out to 1 pixel 1 bit in the following explanation, it is clear that what expressed 1 pixel by the multiple value, and the thing which carried out photoelectric conversion with the color scanner, and gave sexual desire news are also applicable only by adding a slight change to processing.

[0018]With the software of the control section 2, outline extraction is performed to the picture in the memory 51, and it stores in the memory 52. Since the outline extraction should just use a publicly known technique, it is omitted for details. What is called a connected area extraction method may be used instead of outline extraction. Next, as it mentions later, the coordinates of the four corners are searched for from the contour data in the memory 52, and it stores in the memory 53. Next, inclination correction processing is performed to the contour data in the memory 52, and the contour data after amendment is stored in the memory 54. The picture which smeared away the inside from the contour data after this amendment is generated, and the picture which carried out inclination correction to the memory 51 is acquired. After the completion of amendment, by a dialog with the user using the console 6, the address in the file 7 which should store this picture is determined, and it stores in the file 7.

[0019]Extraction of four corners and details of inclination correction processing are given using drawing 5. Drawing 5 is a figure explaining the flow of these processings. The flow of processing is written in PAD (Program Analysis Diagram) form. The contour data (it is in the memory 52) of a document image is inputted by 101. 102 is the loop control about the outline i. It is the sum and the difference (X(i)-Y(i)) of the contour data of each outline to the X coordinate and a Y coordinate at 103 (X(i)+Y(i)),

******** and the minimum are extracted. The coordinates (PXi, PYi) of four corners of i to an

outline where i gives the number on an outline, and this four figure, (QXi, QYi), (RXi, RYi) (SXi, SYi),
********. (It is cautious of differing from four corners of the bounding rectangle mentioned later).
[0020]104-108 are portions which perform ruled line decision processing. Maximum R_{max} is initialized in 103. 104 is the loop control about the outline i.
[0021]In the case of the new maximum, R_{max} is updated by 106 107, comparing the ratio of the width Wi to the height Hi with the maximum till then, and i at that time is registered as im.
[0022]In 108, when going into the range which judges whether it goes into the range with the width Wi and the height Hi of the outline im, it asks for the inclination theta of the outline im which judged with the outline im being a level ruled line (thing most long and slender when there are more than one), and was judged by 109 to be a ruled line. however, theta=arctan ((SYi-RYi)/(SXi-RXi)) -- 110 is an exit when it fails again.
[0023]111-116 are portions which generate the picture which carried out inclination correction processing. 111 clears the outputted image area B. 112 is the loop control about the outline i. 113 is the loop control about the point j which constitutes the outline i. 114 is the coordinates (Xj, Yj) which carried out inclination correction of the coordinates (Xj, Yj) of the point j Formula Yj'=Yj-Xj-tan (theta)
It is the processing for which it asks "Be alike." 115 is processing which sets the pixel B (Xj, Yj) to 1, and maps the sequence-of-points data of the outline i on outputted image area. 116 is processing which smears away the inside of an outline, it is black and an inside is smeared [an inner contour] away by the inside H at an outer contour. If an inner contour is smeared away after smearing away an outline, an original pattern will be restored thoroughly.
[0024]Inclination correction shifts, and modification is used so that I may be understood from the above explanation, but centrifugal distortion can also be used.
[0025]The up-and-down neighborhood or right-and-left neighborhood of a table can also be used instead of a ruled line by changing the logic of a ruled line judging of 108.
[0026]Next, the example of this invention is described.
[0027]The composition of the device which adopted the document processing device by this example is the same as that of the example described previously, and the processings in the control section 2 differ. By this example, inclination of a character string is detected, inclination correction is performed, and since a different point from the example explained previously is a portion of detected inclination, this portion is explained.
[0028]Drawing 6 is a flow chart of processing of the detected inclination in the 2nd example. It corresponds to the portion which performs ruled line decision processing of 103-107 of drawing 5.
In drawing 6, 201-211 are portions which detect inclination of a character string. 201 sets V_{max} to an initial value. 202 is the loop control about the angle alpha. 203 sets the initial value of V (alpha) to 0. 204 is buffer area H (k) and k= 0.1 (N-1),
It clears zero times. 205 is the loop control about the outline i. 206 is coordinates (QXi, QYi) of the both ends of the lower side of the bounding rectangle of the outline i (RXi, RYi),
********. 207 performs processing after 208, only when going into the range with the size of the outline i. 208 calculates H(Kj) <-H(Kj)+|QXj-RXj|, however Kj=QYj-QXj-tan (alpha). An end of the loop about the outline i will calculate the sharpness of the side length marginal distribution of the direction of alpha by 209 by following formula V(alpha) = sigma|H (k)-H(k-1) |. 210,211 updates value alpham of alpha and maximum V_{max} which give the maximum of V

(alpha). alpham when the loop of 202 is ended gives inclination of a character string.
[0029]In the 1st example and 2nd example, it presupposed that a ruled line or a character string is almost level so that I might be understood from the above explanation, but even if it is when these are vertical, it is easy to change the contents of processing such. These inclination is level, or, or even when unknown, it is easy to correct the contents of processing so that the straight line of a level or vertically near direction may be chosen and inclination correction may be carried out using it.
[0030]
[Effect of the Invention]Since the target operation is only an outline of a black area instead of all the pixels in inclination correction and the throughput is decreasing remarkably, by this invention, inclination correction of a document can be performed at high speed, so that I may be understood from the above explanation.
[0031]The document in which a ruled line does not exist can also be amended in this invention which pays its attention to a character string. Since the size of the outline was judged, it integrated only with the outline appropriate for a character and patterns and noises other than a character are excepted from integration, rapidity and noise-proof nature can be combined.

TECHNICAL FIELD

[Industrial Application]This invention relates to an image processing device, especially relates to the suitable image processing device for normalization of inclination of a document image.

PRIOR ART

[Description of the Prior Art]In conventional document image processing, especially binary document image processing, after performing photoelectric conversion and digitization for a picture and changing an inputted image into a digital image, usually it processes. Under the present circumstances, the device for the photoelectric conversion and digitization to be used is called a scanner. In the case of the human power of a picture, the relative inclination by the document and a scanner is not avoided, but inclination of the picture produced as a result has an adverse effect on document image processing, for example, extraction of the character string in a document. Even if it can make relative inclination by the document and a scanner very small, when the case where a document is drawn up with a typewriter, and a document are copied, the character string in a document may lean from the first to the paper.
[0003]Conventional technology is integrated with a document image to two or more directions, in order to cope with such a problem, A direction which serves as a peak is searched for, and the way the direction rotates a document image only the edge of space and the angle to make is known, for example, the integral value is reported by the Institute of Electronics and Communication Engineers national conference lecture collected papers No. 1769th "character logging method on the list which has a black background" in the Showa 59 fiscal year. However, this method had the problem that a throughput became huge, in order to calculate about the gray level of all the pixels.

EFFECT OF THE INVENTION

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]The purpose of this invention is to provide the document image processing device which can amend inclination of a picture at high speed.
[0005]

MEANS

[Means for Solving the Problem]In order to attain this purpose, this invention extracts inclination of a straight-lines portion, such as a ruled line, from an outline extracted from a picture by performing outline extraction, and amends inclination of a picture at high speed by amending inclination so that inclination of this straight-line portion may become level (or vertical).
[0006]The principle is shown in drawing 1. A picture acquired by drawing 1's (A's)'s performing an example of a document image, and (B) performing outline extraction from (A) and (C) show a picture which extracted only an outer contour in (B). The outline 21 of (B) is obtained corresponding to the ruled line 11 of (A). 21 of (C) shows the same outline. An outline is distinguishable as an inner contour, if it is expressed as a coordinate sequence when seeing and going around a black material on the left, it goes around an it top counterclockwise in that case and it will go around to an outer contour and a clockwise rotation.
[0007]A contour coordinate series is set to ((Xj, Yj), j= 0, 1 and 2, L-1) (L is the length of sequence of points). It can ask for four corners of the outline 21 like drawing 1 (D) by searching for a point of giving the maximum and the minimum of quantity (Xj-Yj) of two pieces, and (Xj+Yj) at this time. However, (D) has expanded and shown the outline 21.
[0008]Only a long and slender outline can be extracted by asking for four corners of an outline about all the outlines, and finding a distance in the meantime. When it turns out that only a ruled line (it is level) and a character part exist on a document, the above-mentioned long and slender outline is a ruled line, and can ask also for the horizon and an angle to make using coordinates of outline 4 corner. What is necessary is just to rotate the whole document image using this angle, so that a ruled line may become level. Although a ruled line is one intelligible example, as theoretically shown in drawing 1 (c), each outline of each character has also turned to a direction with specific ** and its neighborhood in many cases.
[0009]Although rotation may carry out straight-line rotation of the original image, after transforming about a contour coordinate series, it may be returned to a picture. When long and slender patterns other than a ruled line exist on a document, the linearity of sequence of points which connect between outline 4 corners is authorized, and only a ruled line can be extracted. What is necessary is to extract only the horizon and a perpendicular line (almost level or vertically near line) in quest of a slope of a line similarly, and just to amend inclination of a

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EXAMPLE

[Example]Hereafter, the example of this invention is described in detail using a drawing.

[0017]Drawing 4 is a block diagram showing the composition of the device which adopted the word-processing method by one example of this invention. Each part of a device is connected to the bus 1, and the whole operation is controlled by the control section 2. Photoelectric conversion and digitization of the information (document image) on the document 3 are done with the scanner 4, it serves as a digital image, and is stored in the memory 51 via the bus 1. The memory 51 makes a part of memory 5 with 52, 53, and 54 which are mentioned later. Instead of obtaining the digital image 51 from the scanner 4, you may also read from digital image filing devices, such as an optical disc. Although binarization shall be carried out to 1 pixel 1 bit in the following explanation, it is clear that what expressed 1 pixel by the multiple value, and the thing which carried out photoelectric conversion with the color scanner, and gave sexual desire news are also applicable only by adding a slight change to processing.

[0018]With the software of the control section 2, outline extraction is performed to the picture in the memory 51, and it stores in the memory 52. Since the outline extraction should just use a publicly known technique, it is omitted for details. What is called a connected area extraction method may be used instead of outline extraction. Next, as it mentions later, the coordinates of the four corners are searched for from the contour data in the memory 52, and it stores in the memory 53. Next, inclination correction processing is performed to the contour data in the memory 52, and the contour data after amendment is stored in the memory 54. The picture which smeared away the inside from the contour data after this amendment is generated, and the picture which carried out inclination correction to the memory 51 is acquired. After the completion of amendment, by a dialog with the user using the console 6, the address in the file 7 which should store this picture is determined, and it stores in the file 7.

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[0021]In the case of the new maximum, R_{max} is updated by 106 107, comparing the ratio of the width Wi to the height Hi with the maximum till then, and i at that time is registered as im.
[0022]In 108, when going into the range which judges whether it goes into the range with the width Wi and the height Hi of the outline im, it asks for the inclination theta of the outline im which judged with the outline im being a level ruled line (thing most long and slender when there are more than one), and was judged by 109 to be a ruled line. however, theta=arctan ((SYi-RYi)/(SXi-RXi)) -- 110 is an exit when it fails again.
[0023]111-116 are portions which generate the picture which carried out inclination correction processing. 111 clears the outputted image area B. 112 is the loop control about the outline i. 113 is the loop control about the point j which constitutes the outline i. 114 is the coordinates (Xj, Yj) which carried out inclination correction of the coordinates (Xj, Yj) of the point j Formula Yj'=Yj-Xj-tan (theta)
It is the processing for which it asks "Be alike." 115 is processing which sets the pixel B (Xj, Yj) to 1, and maps the sequence-of-points data of the outline i on outputted image area. 116 is processing which smears away the inside of an outline, it is black and an inside is smeared [an inner contour] away by the inside H at an outer contour. If an inner contour is smeared away after smearing away an outline, an original pattern will be restored thoroughly.
[0024]Inclination correction shifts, and modification is used so that I may be understood from the above explanation, but centrifugal distortion can also be used.
[0025]The up-and-down neighborhood or right-and-left neighborhood of a table can also be used instead of a ruled line by changing the logic of a ruled line judging of 108.
[0026]Next, the example of this invention is described.
[0027]The composition of the device which adopted the document processing device by this example is the same as that of the example described previously, and the processings in the control section 2 differ. By this example, inclination of a character string is detected, inclination correction is performed, and since a different point from the example explained previously is a portion of detected inclination, this portion is explained.
[0028]Drawing 6 is a flow chart of processing of the detected inclination in the 2nd example. It corresponds to the portion which performs ruled line decision processing of 103-107 of drawing 5.
In drawing 6, 201-211 are portions which detect inclination of a character string. 201 sets V_{max} to an initial value. 202 is the loop control about the angle alpha. 203 sets the initial value of V (alpha) to 0. 204 is buffer area H (k) and k= 0.1 (N-1),
It clears zero times. 205 is the loop control about the outline i. 206 -- coordinates (QXi, QYi) (RXi, RYi) of the both ends of the lower side of the bounding rectangle of the outline i, ********. 207 performs processing after 208, only when going into the range with the size of the outline i. 208 calculates H(Kj) <-H(Kj)+|QXj-RXj|, however Kj=QYj-QXj-tan (alpha). An end of the loop about the outline i will calculate the sharpness of the side length marginal distribution of the direction of alpha by 209 by following formula V(alpha) = sigma|H (k)-H(k-1) |. 210,211 updates value alpham of alpha and maximum V_{max} which give the maximum of V (alpha). alpham when the loop of 202 is ended gives inclination of a character string.

[0029]In the 1st example and 2nd example, it presupposed that a ruled line or a character string is almost level so that I might be understood from the above explanation, but even if it is when these are vertical, it is easy to change the contents of processing such. These inclination is level, or, or even when unknown, it is easy to correct the contents of processing so that the straight line of a level or vertically near direction may be chosen and inclination correction may be carried out using it.

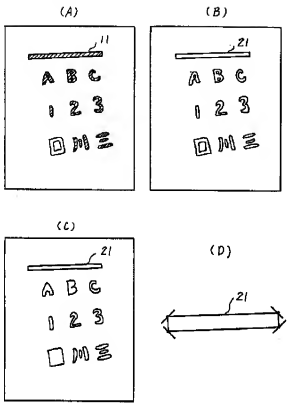
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The figure explaining the principle of this invention.
[Drawing 2]The figure explaining the principle of this invention.
[Drawing 3]The figure explaining the principle of this invention.
[Drawing 4]The block diagram showing the composition of the device which carries out the word-processing method of this invention.
[Drawing 5]The flow chart of the processing in the control section 2 of drawing 4.
[Drawing 6]The flow chart of the processing in the control section 2 of drawing 4.
[Drawing 7]The mimetic diagram explaining the principle of the invention in this application
[Description of Notations]
1 [-- A scanner, 5 / -- A memory, 6 / -- A console, 7 / -- File.] -- A bus, 2 -- A control section, 3 -- A document, 4

DRAWINGS

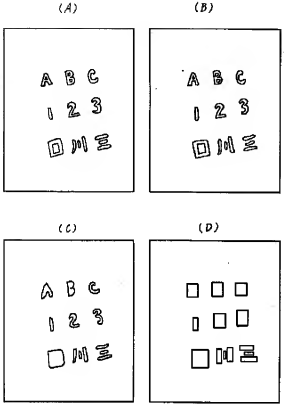
[Drawing 1]

図 1



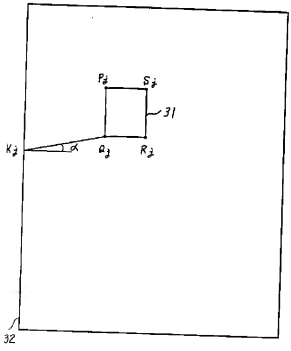
[Drawing 2]

図 2



[Drawing 3]

図 3



[Drawing 4]

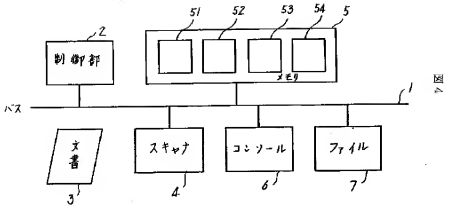
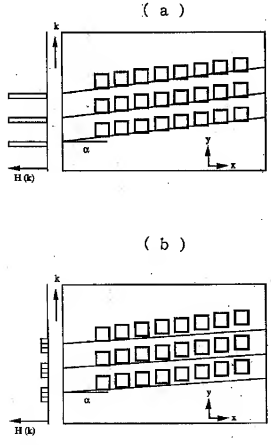


図 4

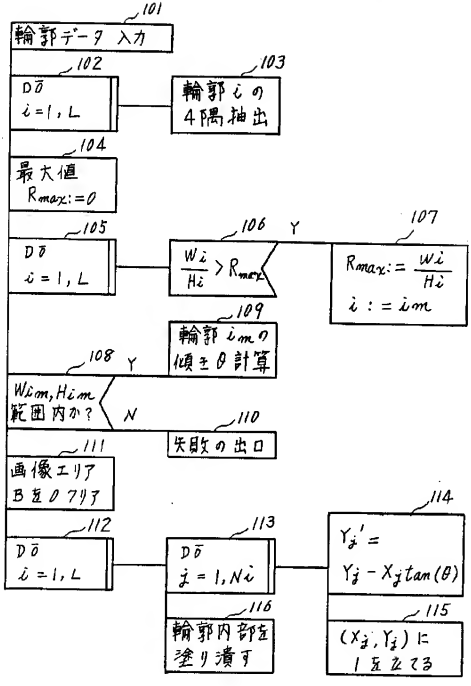
[Drawing 7]

図 7



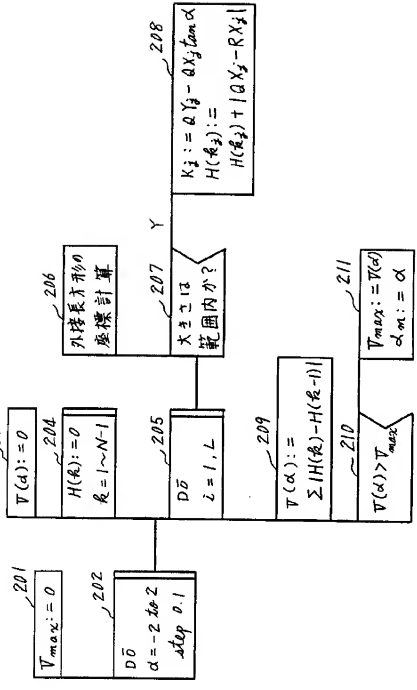
[Drawing 5]

図 5


101
輪郭データ 入力
102
Do i = 1, L
103
輪郭 i の 4隅抽出
104
最大値 Rmax := 0
105
Do i = 1, L
106
Wi/Hi > Rmax
Y
107
Rmax := Wi/Hi
i := im
109
輪郭 im の傾き θ 計算
108
Wim, Him 範囲内か？
Y
N
110
失敗の出口
111
画像エリア B五0フリア
112
Do i = 1, L
113
Do j = 1, Ni
114
Yj' = Yj - Xj tan(θ)
115
(Xj, Yj) に 1を立てる
116
輪郭内部を塗り潰す

[Drawing 6]

図 6


201
$V_{max} := 0$
202
Dō
$\alpha = -2$ to 2
step 0.1
203
$V(\alpha) := 0$
204
$H(k) := 0$
$k = 1 \sim N-1$
205
Dō
$i = 1, L$
206
外接長方形の
座標計算
207
大きさは
範囲内か？
Y
208
$K_j := Q Y_j - Q X_j \tan\alpha$
$H(k_j) := H(k_j) + |Q X_j - R X_j|$
209
$V(\alpha) :=$
$\sum |H(k) - H(k-1)|$
210
$V(\alpha) > V_{max}$
211
$V_{max} := V(\alpha)$
$\alpha_m := \alpha$

Your Ref: 07844-249JP1
Our Ref: PA941

Translation of Selected Portions of Pat. Laid-open Official Gazette

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Division of Pat. Appln. No. 60-152210
Laid-open Pub. No: 9-120430
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Attorney(s): Katsuo Ogawa

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1. Title of the Invention

IMAGE PROCESSING APPARATUS

2. Claims

(omitted)

3. Detailed Description of the Invention (Selected Portions)

1)

(omitted)

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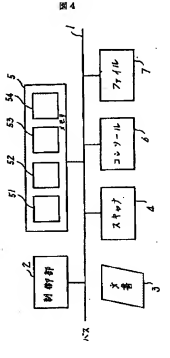
最終頁に続く

(54)【発明の名称】　画像処理装置

(57)【要約】
【目的】本発明の目的は、画像の傾きを高速に補正できる文書画像処理装置を提供することにある。
【構成】デジタル画像情報を入力する入力手段4と、上記デジタル画像情報を格納するメモリ5と、該メモリ中のデジタル画像情報の処理を行なう制御部2とを有し、該制御部は上記デジタル画像情報の輪郭データを抽出する手段、該輪郭データを演算して特徴量を算出する手段、該特徴量を複数の方向に投影して積分して積分値を得る手段、該積分値が極値を取る方向を抽出する手段を有する画像処理装置。

図4



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【特許請求の範囲】

【請求項１】デジタル画像情報を入力する入力手段と、上記デジタル画像情報を格納するメモリと、該メモリ中のデジタル画像情報の処理を行なう制御部とを有し、該制御部は上記デジタル画像情報の輪郭データを抽出する手段、該輪郭データを演算して特徴量を算出する手段、該特徴量を複数の方向に投影して積分して積分値を得る手段、該積分値が極値を取る方向を抽出する手段を有する画像処理装置。

【請求項２】文書をデジタル画像情報化して入力する入力手段と、上記デジタル画像情報を格納するメモリと、該メモリ中のデジタル画像情報の処理を行なう制御部とを有し、

該制御部は上記デジタル画像情報中の文字データの輪郭データを抽出する手段、該輪郭データを演算して特徴量を算出する手段、該特徴量を複数の方向に投影して積分して積分値を得る手段、該積分値が極値を取る方向を抽出する手段を有する画像処理装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は画像処理装置に係り、特に文書画像の傾きの正規化に好適な画像処理装置に関する。

【０００２】

【従来の技術】従来の文書画像処理、特に二値文書画像処理において、画像を光電変換及びディジタル化を行って、入力画像をディジタル画像に変換してから処理を行うのが普通である。この際用いる光電変換及びディジタル化のための装置をスキャナと呼ぶ。画像の人力の際、文書とスキャナとの相対的な傾きは避けられず、その結果生ずる画像の傾きは文書画像処理、たとえば文書中の文字列の抽出に悪影響を及ぼす。また文書とスキャナとの相対的な傾きを極めて小さくできたとしても、文書をタイプライタで作成する場合や文書を複写した場合など、文書中の文字列が用紙に対し元々傾いていることもある。

【０００３】従来技術ではこのような問題点に対処するため、文書画像を複数の方向に対して積分し、その積分値がピークとなるような方向を求め、その方向が紙面のエッジとなす角度だけ文書画像を回転する方法が知られており、たとえば昭和５９年度電子通信学会全国大会講演論文集第1769番「黒色背景を有する帳票上の文字切り出し方式」で報告されている。しかし、この方法は全ての画素の濃淡値について演算を行なうために、処理量が膨大となるという問題があった。

【０００４】

【発明が解決しようとする課題】本発明の目的は、画像の傾きを高速に補正できる文書画像処理装置を提供することにある。

【０００５】

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【課題を解決するための手段】かかる目的を達成するために、本発明は、画像から輪郭抽出を行い、抽出された輪郭から罫線など直線部分の傾きを抽出して、この直線部分の傾きが水平（あるいは垂直）になるように傾きを補正することにより画像の傾きを高速に補正することを特徴とする。

【０００６】図１にその原理を示す。図１（Ａ）は文書画像の例、（Ｂ）は（Ａ）から輪郭抽出を行って得られる画像、（Ｃ）は（Ｂ）の中で外輪郭だけを抽出した画像を示す。（Ａ）の罫線１１に対応して、（Ｂ）の輪郭２１が得られる。（Ｃ）の２１は同じ輪郭を示す。輪郭は、その上を黒地を左に見て一周するときの座標系列として表現されており、その場合反時計方向に一周するならば外輪郭、時計方向に一周するならば内輪郭として区別できる。

【０００７】輪郭座標系列を（Ｘｊ，Ｙｊ），ｊ＝０，１，２，，，（Ｌ－１）とする（Ｌは点列の長さ）。このとき２個の量（Ｘｊ－Ｙｊ），（Ｘｊ＋Ｙｊ）の最大値及び最小値を与える点を求めることにより、図１（Ｄ）のように輪郭２１の４隅を求めることができる。ただし、（Ｄ）では輪郭２１は拡大して示してある。

【０００８】全ての輪郭について輪郭の４隅を求め、その間の距離を求めることにより、細長い輪郭のみを抽出することができる。文書上に（水平の）罫線と文字部のみしか存在しないことが分っている場合、上記の細長い輪郭は罫線であり、その水平線となす角度もまた輪郭４隅の座標を用いて求めることができる。この角度を用いて、罫線が水平となるように文書画像全体を回転すればよい。罫線は判り易い一つの例であるが、原理的には図１（ｃ）に示すように各文字の輪郭それぞれも、もその辺が特定の方向を向いていることが多い。

【０００９】回転は、原画像を直線回転してもよいが、輪郭座標系列について座標変換した後、画像に戻してもよい。また、文書上に罫線以外の細長い模様が存在するときは、輪郭４隅の間を結ぶ点列の直線性を検定して罫線のみを抽出できる。また、文書上の直線として縦線や垂直線も存在するときは、同様に直線の傾きを求めて水平線と垂直線（ほぼ水平または垂直に近い線）のみを抽出し、そのどちらかを用いて傾きを補正することにより画像の傾きを高速に補正すればよい。

【００１０】また、本発明の態様においては、画像から抽出された輪郭に対して特徴量を求め、この特徴量をいろいろな方向に積分し、その積分値がピークとなるような方向を求め、その方向が紙面のエッジとなす角度だけ傾きを補正することにより画像の傾きを高速に補正するものである。

【００１１】画像から抽出された輪郭に対する特徴量の例としては、輪郭（外輪郭）に外接する長方形を作り、その縦または横の辺の長さを取ることができる。この方法は、罫線が存在しない場合に文字列の傾きを求めるた

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めに使用できる。他の例としては、長方形の面積や、これらの値をもとに求められた任意の関数値を考えることができる。

【0012】図2，図3にその原理を示す。図2（A）は文書画像の例、（B）は（A）から輪郭抽出を行って得られている画像、（C）は（B）の中で外輪郭だけを抽出した画像を示す。（C）の外輪郭から（D）のような外接長方形を作る。外接長方形の座標は、輪郭点列座標の最大値と最小値とから容易に求められるが、これを（PXj，PYj），（QXj，QYj），（RXj，RYj），（SXj，SYj）

とする。ここで、P，Q，R，Sはそれぞれ、外接長方形jの左上、左下、右上を表す。すなわち、

（QXj，QYj），（RXj，RYj）

はそれぞれ、外接長方形jの下辺の画像を表す。このとき、ある角度αに対し次の量V（α）を計算する。まず、ヒストグラムを格納する配列

H（k），k＝0，1，，（N－1）

をQクリアする。N文書画像をM×Nとしたときの縦の長さである。つぎに、jに関するループにより

H（Kj）←H（Kj）＋｜QXj－RXj｜

ただし、Kj＝G［QYj－QXj・tan（α）］を計算する。上記において記号「←」は代入を意味し、G［x］は実数xを整数に変換する関数を示す。

【0013】図3に示すようにKjは、31の外接長方形jの左下隅の点Qjから角度αの直線を引いたとき、画像の左辺32と交わる点のY座標である。したがって、ヒストグラムH（Kj）は角度αだけ画像を傾けて外接長方形jの下辺の長さを積分することに相当する。これを角度α方向の辺長周辺分布と呼ぶ。jに関するループが終了すると

V（α）＝Σ｜H（k）－H（k－1）｜

を計算する。V（α）は角度α方向の辺長周辺分布の鋭さを表す量である。角度αを例えば－2°から＋2°まで0.1°きざみで変化させ、V（α）の最大となる角度を求めることにより、外接長方形の下辺が最もよく重なるような方向が求まる。一般に文字の行はほぼ下辺が揃って印刷あるいは書かれるから、これが同じ線上に並ぶような角度は文字列の傾きと考えることができる。

【0014】図7を用いて特徴値として矩形の底辺の長さを用いた場合について、さらに判り易く説明する。図7（a）は、ヒストグラムH（K）を傾き角と等しい角度αで求めたときの図である。文字の外接矩形が四角の列で示されている。同図に示すように傾き角と等しい方向に矩形の底辺の長さを積分すると、ヒストグラムは各文字行に対応した位置に大きな値を持つ。もし、文字の輪郭を示す矩形がまったく規則的であったとすると各矩形の左下隅の点は一直線状に並び、同図に示すようにヒストグラムは対応する位置のみにピークをもつ。よって、これに対するV（α）は、H（K）のとなり同士の

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値の差分を積分した値なので、大きな値をとることになる。実際には、文字パターンはそれぞれ形状や大きさが異なるが、その場合でも、ヒストグラムの示す傾向は変わらない。

【0015】一方、積分する方向αが図7（b）のように傾き角と異なる場合には、鋭いピークは現われずに、各文字行に対応する位置の周りに分布を持つ。よってこれに対するV（α）は図7（a）に比べてずっと小さい。このように複数の方向についてV（α）を計算することで、傾き角度に近いαのときにV（α）が最大になることを利用して、画像の傾きを知ることができる。この例では文字に外接する矩形の辺の長さを特徴量としたが、矩形の面積を特徴量としても同様の効果が得られることは明白である。

【0016】

【実施例】以下、本発明の実施例について図面を用いて詳細に説明する。

【0017】図4は本発明の一実施例による文書処理方式を採用した装置の構成を示すブロック図である。装置の各部はバス1に接続され、全体の動作は制御部2により制御される。文書3上の情報（文書画像）はスキャナ4により光電変換・ディジタル化されてディジタル画像となり、バス1を介してメモリ51に格納される。メモリ51は後述する52，53，54とともにメモリ5の一部をなす。ディジタル画像51をスキャナ4から得る代わりに、光ディスクなどのディジタル画像ファイル装置から読みこんでもよい。また、以下の説明では1画素1ビットに二値化するものとするが、1画素を多値で表現したものや、カラースキャナにより光電変換して色情報を付与したものでも、処理に僅かの変更を加えるのみで適用できることは明らかである。

【0018】制御部2のソフトウェアにより、メモリ51中の画像に対し輪郭抽出を行い、メモリ52に格納する。輪郭抽出は公知の手法を使用すればよいので詳細は省略する。輪郭抽出の代わりにいわゆる連結領域抽出法を使用してもよい。次に後述するようにして、メモリ52の中の輪郭データからその4隅の座標を求め、メモリ53に格納する。次にメモリ52中の輪郭データに対し傾き補正処理を行い、補正後の輪郭データをメモリ54に格納する。この補正後の輪郭データから内部を塗り潰した画像を生成し、メモリ51に傾き補正した画像を得る。補正完了後、コンソール6を用いた使用者との対話により、この画像を格納すべきファイル7中のアドレスを決定し、ファイル7に格納する。

【0019】図5を用いて4隅の抽出と傾き補正処理の詳細を述べる。図5は、これらの処理の流れを説明する図である。処理の流れは、PAD（Program Analysis Diagram）形式で書かれている。101で文書画像の輪郭データ（メモリ52中にある）を入力する。102は、輪郭iに関するループ制御である。103で各輪郭の輪

郭データからその X 座標及び Y 座標の和及び差
（X（i）－Y（i）），（X（i）＋Y（i））
の最大値及び最小値を抽出する。 i は輪郭上の番号、この４個の数値を与える i から輪郭の４隅の座標
（PXi，PYi），（QXi，QYi），（RXi，RYi），（SXi，SYi）
が決まる。（後述した外接長方形の４隅とは異なることに注意）。

【００２０】１０４～１０８は罫線判定処理を行う部分である。１０３では最大値 R_{max} の初期化を行う。１０４は、輪郭 i に関するループ制御である。

【００２１】１０６で幅 Wi と高さ Hi の比をそれまでの最大値と比較し、新しい最大値の場合は１０７で R_{max} を更新しそのときの i を i m として登録する。

【００２２】１０８では輪郭 i m の幅 Wi と高さ Hi がある範囲に入っているかを判定する、範囲に入っているとき、輪郭 i m は水平の罫線（複数ある時は最も細長いもの）であると判定し、１０９で罫線と判定された輪郭 i m の傾き θ を求める。ただし、　θ＝arctan((SYi－RYi)／(SXi－RXi))
また、１１０は、失敗したときの出口である。

【００２３】１１１～１１６は傾き補正処理した画像を生成する部分である。１１１は、出力画像エリア B をクリアする。１１２は、輪郭 i に関するループ制御である。１１３は、輪郭 i を構成する点 j に関するループ制御である。１１４は点 j の座標（Xj，Yj）を傾き補正した座標（Xj，Yj）を計算式
Yj'＝Yj－Xj・tan（θ）
によって求める処理である。１１５は画素 B（Xj，Yj）を１とするもので、出力画像エリア上に輪郭 i の点列データをマッピングする処理である。１１６は輪郭内部を塗り潰す処理であり、外輪郭では内部を黒で、内輪郭では内部 H で塗り潰す。輪郭を塗り潰した後、内輪郭を塗り潰すようにすれば、原パターンが完全に復元される。

【００２４】以上の説明から理解されるように、傾き補正はずれ変形を用いているが、回転変形を用いることもできる。

【００２５】また、１０８の罫線判定の論理を変更することにより罫線の代りに表の上下辺あるいは左右辺を使用することもできる。

【００２６】次に、本発明の実施例について説明する。

【００２７】本実施例による文書処理装置を採用した装置の構成は先に説明した実施例と同様であり、制御部２における処理が異なっている。本実施例では、文字列の傾きを検出して傾き補正を行うものであり、先に説明した例と異なる点は傾き検出の部分であるので、この部分について説明する。

【００２８】図６は、第２の実施例における傾き検出の処理の流れ図であり、図５の１０３～１０７の罫線判定処理を行う部分に対応する。図６で、２０１～２１１は文字列の傾きを検出する部分である。２０１は、V_{max} を初期値にセットする。２０２は、角度 α に関するループ制御である。２０３は V（α）の初期値を０にセットする。２０４はバッファエリア
H（k），k＝0．1，，（N－1）
を０クリアする。２０５は輪郭 i に関するループ制御である。２０６は、輪郭 i の外接長方形の下辺の両端の座標
（QXi，QYi），（RXi，RYi）
を求める。２０７は輪郭 i の大きさがある範囲に入っているときのみ２０８以降の処理を行う。２０８は
H（Kj）←H（Kj）＋｜QXj－RXj｜
ただし、Kj＝QYj－QXj・tan（α）を計算する。輪郭 i に関するループが終了すると２０９で α 方向の辺長周辺分布の鋭さを、次式
V（α）＝Σ｜H（k）－H（k－1）｜
によって計算する。２１０，２１１は V（α）の最大値を与える α の値 α m及び最大値 V_{max} を更新する。２０２のループを終了したときの α m が文字列の傾きを与える。

【００２９】以上の説明から理解されるように、第１の実施例及び第２の実施例では罫線あるいは文字列はほぼ水平であるとしたが、これらが垂直の場合であっても処理内容をそのように変更することは容易である。また、これらの傾きが水平か垂直か不明の場合でも、水平あるいは垂直に近い方向の直線を選択し、それを用いて傾き補正するように処理内容を修正することは容易である。

【００３０】

【発明の効果】以上の説明から理解されるように、本発明では傾き補正で対象とする演算が全画素ではなく、黒領域の輪郭のみであるので処理量が著しく減少しているため、文書の傾き補正を高速に行うことができる。

【００３１】また、文字列に着目する本発明では、罫線の存在しない文書でも補正が可能である。また輪郭の大きさを判定して文字らしい輪郭のみ積分し、文字以外の模様や雑音を積分から除外しているので、高速性と耐雑音性を兼ね備えることができる。

【図面の簡単な説明】

【図１】本発明の原理を説明する図。

【図２】本発明の原理を説明する図。

【図３】本発明の原理を説明する図。

【図４】本発明の文書処理方式を実施する装置の構成を示すブロック図。

【図５】図４の制御部２における処理の流れ図。

【図６】図４の制御部２における処理の流れ図。

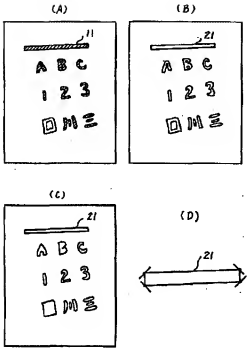
【図７】本願発明の原理を説明する模式図

【符号の説明】

１…バス、２…制御部、３…文書、４…スキャナ、５…メモリ、６…コンソール、７…ファイル。

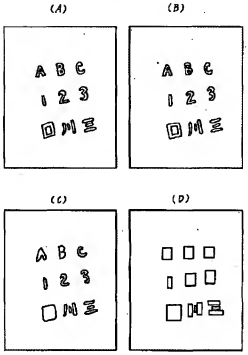
【図1】

図1



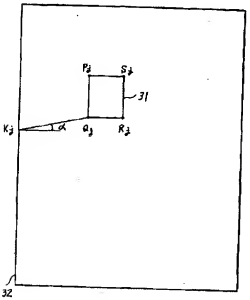
【図2】

図2



【図3】

図3



【図4】

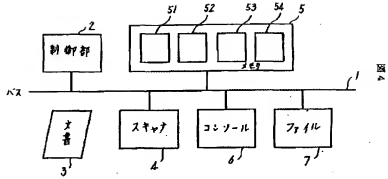
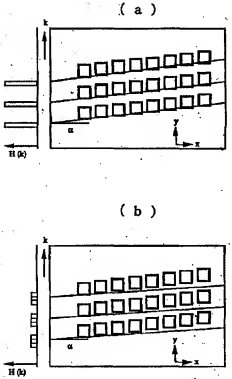

51
52
53
54
5
2
制御部
メモリ
1
バス
文書
スキャナ
コンソール
ファイル
3
4
6
7

図4

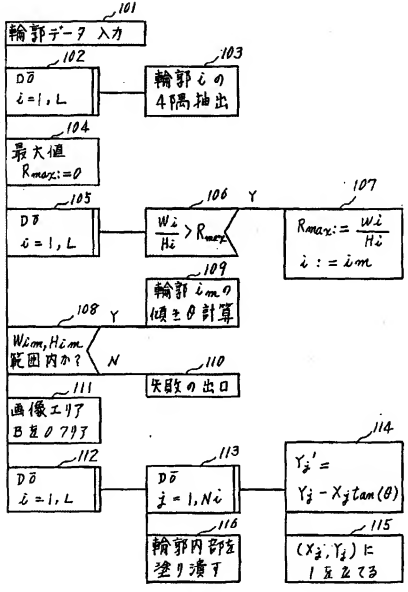
【図7】

図 7


(a)
k
α
y
x
H (k)
(b)
k
α
y
x
H (k)

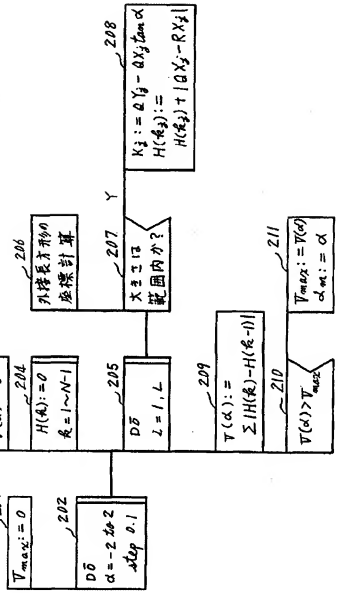
【図5】

図5


101
輪郭データ入力
102
Do i=1, L
103
輪郭 i の 4隅抽出
104
最大値 Rmax:=0
105
Do i=1, L
106
Wi/Hi > Rmax
Y
107
Rmax:= Wi/Hi
i:=im
109
輪郭 im の傾き θ 計算
108
Wim, Him 範囲内か？
Y
N
110
失敗の出口
111
画像エリア B左0 7J7
112
Do i=1, L
113
Do j=1, Ni
114
Yj' = Yj - Xj tan(θ)
115
(Xj, Yj) に 1左立てる
116
輪郭内部を塗り潰す

【図6】

図 6



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